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A FURTHER NOTE ON THE LIFE-HISTORY OF *GONGYLONEMA SCUTATUM* *

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In two recent papers, one of which is an admirable monograph of the larval forms of the heteroxenous parasitic nematodes and the other a comprehensive study of the Gongyloneminae of North Africa, Seurat (1916: 739; 1916a: 358) has expressed the opinion that certain larval nematodes found in various species of coprophagous beetles (Aphodius, Onthophagus) which we identified (Ransom and Hall, 1915: 154; 1916: 80-86) as the larvae of *Gongylonema scutatum* probably belong to another species, *G. mucronatum* Seurat 1916. The adults of the latter species have been found by Seurat in the mucosa of the esophagus and base of the tongue of the Algerian hedgehog (*Erinaceus algirus* Duv.). It has not yet been recorded from sheep or cattle. Easily recognizable differences between *G. scutatum* and *G. mucronatum* are as follows, the statements relative to structural characters of the latter being taken from Seurat's description:

In *G. scutatum* the cervical papillae are situated about midway between the anterior border of the nerve ring and the anterior end of the body, each in the center of a rounded cuticular shield; in *G. mucronatum* they are situated at the anterior third of the distance between the anterior border of the nerve ring and the anterior end of the body and are not inserted in the center of a cuticular shield. In *G. scutatum* the caudal pores are subterminal, in *G. mucronatum* situated at about two-thirds of the distance between the anus and the tip of the tail. In *G. scutatum* there is no papilla in the neighborhood of the vulva; in *G. mucronatum* an unpaired papilla is situated on the ventral surface of the body about 0.1 mm. behind the vulva.

In view of Seurat's opinion we have examined in detail numerous specimens of Gongylonema collected from the esophagus of sheep and cattle in various parts of the United States and have failed to find among them any corresponding to *G. mucronatum*, or to any species other than *G. scutatum*. If *G. mucronatum* is present in the United States, it is not likely that it occurs in sheep or cattle; at least, it must be rare in these hosts. Consequently, even considering the fact that we did not make a detailed microscopic examination of every worm from which eggs were obtained for feeding to insects in the experiments recorded in our former paper, but depended in many instances upon the gross appearance of the parasites as sufficient for their identification, it seems scarcely possible that there should have been invariably present in the material fed to the insects not only the eggs of *G. scutatum,* but also those of another species, whose presence in the sheep or cattle from which our material was obtained we constantly overlooked. The only apparent possibilities of error affecting our interpretations of the results of our experiments in feeding croton bugs and beetles in addition to the one just mentioned are (1) that the insects were already infested, and (2) that during the progress of the experiments they acquired the parasites from some other source than the material originally fed to them. In the case of the beetles we realized that some of them probably already harbored the parasites at the beginning of the experiments and gave due consideration to this probability in interpreting our observations; but the possibility of such a circumstance in the case of the croton bugs is very slight in view of the fact that we have frequently examined croton bugs caught from the same places as those used in the experiments without finding Gongylonema larvae. The second possibility is also very slight in the case of the croton bugs, as they were kept during the experiments either without access to food or fed only on bread crumbs or similar food unlikely to contain nematode eggs. Furthermore, croton bugs kept in a similar manner and used in other experiments have never shown Gongylonema larvae. The beetles used in our experiments in some instances were kept in containers with unsterilized feces from sheep and consequently might have acquired their parasites from this source, but in certain instances the feces in which the beetles were kept and upon which they fed were sterilized. In the latter case, even with beetles already infested, one would be justified in considering as we did that the newly hatched Gongylonema embryos observed in large numbers a day or two after feeding, and the developing larvae in progressive stages observed later in due course of time, came from the eggs contained in the material fed to the beetles. So far as we are able to perceive after reviewing our records and recollections, our experiments in the feeding of Gongylonema eggs to insects were adequately safeguarded and controlled in all essential respects, with the exception that possibly sufficient care was not taken to exclude the eggs of species other than *G. scutatum.* With this possibility of error in view, slight though it is, the senior author has carried out a new series of experiments in feeding croton bugs.

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The insects used in the recent experiments were kept in flasks closed by cotton plugs. In addition to being supplied with material containing the Gongylonema eggs they were occasionally given fresh bread crumbs and a few drops of water. Numerous individuals caught from time to time in the same place as those used in the experiments were examined and found to be free from infestation. Some were also kept in flasks and fed bread and water, but no Gongylonema eggs, as controls against those fed Gongylonema eggs. The controls remained free from infestation. The Gongylonema material for feeding was obtained from a few infested gullets of sheep and cattle procured at an abattoir. All of the parasites were carefully removed from the gullets. By microscopic examination the fact was established that all of the worms present in each of the gullets corresponded to *G. scutatum,* special attention being given to the cervical papillae, absence of a postvulvar papilla, and subterminal location of the caudal pores. Female worms thus obtained and identified were washed in several changes of physiological salt solution to reduce the chances of foreign eggs adhering to their bodies, cut into small pieces, mixed with bread crumbs, and placed in the flasks containing the captive croton bugs. As in our former experiments, these croton bugs became infested with the larvae of Gongylonema. Individuals were examined at intervals, and various stages ranging from the newly hatched larvae up to the encysted forms, and exhibiting the same characteristics of structure as those described in our former paper, were recovered. An encysted larva taken from a croton bug seven weeks after eggs of *Gongylonema scutatum* were placed in the flask in which it was kept, measured 1.9 mm. in length by 0.06 mm. in diameter. The pharynx was 0.035 mm. in length, the esophagus 1.2 mm., its muscular portion 0.23 mm. The cervical papillae were 0.07 mm. from the anterior end of the body, the nerve ring 0.125 mm., excretory pore 0.21 mm. The anus was 0.09 mm. from the tip of the tail, the caudal pores 0.025 mm.

With reference to our experiments in feeding sheep with infested beetles and croton bugs (Ransom and Hall, 1916) it may be noted that their results if considered by themselves were less conclusive than those of the experiments in feeding Gongylonema eggs to insects, because of the small number of animals used and the lack of complete control of all the conditions which might have affected the experiments. Furthermore, no attempt was made to obtain a series of steps in the development in sheep between the larva and the adult. As a matter of fact in our former paper we did not insist upon the conclusiveness of the sheep-feeding experiments and considered them of importance only when viewed in the light of other evidence without which they would have been much less significant. Even though the experimental evidence that the larvae of *Gongylonema scutatum* in dung beetles develop to maturity in sheep and other suitable mammalian hosts when the insects are ingested by these animals is less complete than that as to the development of the larval stage in the insects, such evidence as we have is in exact accord with that hypothesis, which moreover by analogy is strongly supported by the known facts in the life histories of other parasites, and we are justified in assuming until very definite evidence to the contrary is brought forward, that sheep, cattle, and other suitable host animals become infested with *Gongylonema scutatum* as a result of swallowing infested insects, under natural conditions probably various species of dung beetles.

From the foregoing it is evident that the validity of the results of our work on the life history of *Gongylonema scutatum* has not been affected by the question raised by Seurat regarding the correctness of our identification of the larval nematodes which we found in coprophagous beetles and under experimental conditions in croton bugs. It is also evident that the nematodes found by Seurat (1916: 739, Fig. 5; 1916a: 315, 346) in several species of Blaps, and because of the subterminal position of the caudal pores considered by him to be the larvae of *G. scutatum,* cannot belong to this species, unless it is a species whose larvae are characterized by an unusual degree of polymorphism. Whether the nematodes occurring in various species of coprophagous beetles in Algeria, which are strikingly similar to those which we have shown to be the larvae of *G. scutatum,* belong to *G. mucronatum* as Seurat (1916a: 317, 346, Fig. 11) supposes, remains to be determined. The basis upon which Seurat identified them as *G. mucronatum* is the location of the caudal pores at a considerable distance from the tip of the tail, a character in which they agree with the adults of this species. Clearly, however, apparent similarities in details of structure are not sufficient in the absence of other evidence to justify definite conclusions as to the specific identity of larval and adult nematodes, and further investigations will be necessary before the larvae described by Seurat as such can be accepted as the larvae of *G. mucronatum.* Because of their close agreement in structure with the larvae of *G. scutatum,* it is quite probable that they actually belong to this species, the adult stage of which Seurat has found to be common in Algeria.

SUMMARY

Despite the doubts raised by Seurat in recent publications, the conclusions expressed in our former papers on the life history of *Gongylonema scutatum* are still valid. It has been definitely proved that dung beetles and croton bugs fed upon the eggs of *G. scutatum* become infested with an encysted larval stage of the parasite, and the evidence is very strong, if not quite conclusive, that sheep, cattle, and other suitable mammalian hosts become infested as a result of swallowing infested insects (usually under natural conditions, various species of dung beetles).

The nematodes found in several species of Blaps in Algeria and identified by Seurat as the larvae of *G. scutatum* belong to some other species.

It is not improbable that the nematodes found in Algerian beetles which Seurat has considered to be the larvae of *G. mucronatum* in reality belong to *G. scutatum.*

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